



Cr, Mo, W, V, Ti, Nb are carbide formers and increase abrasive wear.
Al, Ti, V, Nb refine the steel grain structure, making it tougher and thus more difficult to machine.

General Machining, Stamping, Forming	Aluminum Machining	Aluminum Machining	General Machining, Stamping, Forming	Machining with Insert	Drilling and Milling	Milling General Machining	Drilling and Milling	Milling Hard Machining / Stainless Steel	Drilling / Milling	General Drilling	Sliding Layer as Top Coating	Steel Stainless Steel - Threading	Titanium Machining	Hard Machining - Thin Coating for Precision Tools	Milling - Alloyed and Unalloyed Steel
TiN	HE A Zr	HE A	HE B	AlTiN 4 M	HE B plus	HE X	HE S	HE S6 F	HE S6P	HE S6 B	ZrN	HE Z	HE A plus	HE P2	HE P3
TiN	CrTiAlN + ZrN	CrTiAlN	AlTiN Multilayer	AlTiN Nanolayer	AlTiSiN Multilayer	AlTiN	AlTiSiN	AlTiSiN + TiSiN	AlCrSiN + AlTiSiN	AlTiSiN + TiSiN	ZrN	TiCN	TiCrCN based	AlCrN + AlCrSiN	AlCrN + AlCrSiN

Coating Overview

	Designation		Color	Microhardness [GPa]	Operating Temperature	Standard Coating Thickness	Thin-Film Variant
General Machining, Stamping/Forming	TiN	TiN	gold	25	650°C	3,5 µm ± 0,5	1,2 µm ± 0,2
Machining with Inserts	AlTiN 4 M	AlTiN Nanolayer	gray black	35	1100°C	8 µm ± 2	4 µm ± 1
Sliding Layer as Top Coating	ZrN	ZrN	zirconium	22	600°C	0,5 µm	
General Machining, Stamping/Forming	HE B	AlTiN / TiAlN Multilayer	schwarz-violet	33	850°C	3,5 µm ± 0,5	1,3 µm ± 0,3
Drilling and Milling	HE S	AlTiSiN	purple-taupe	36	1100°C	3,0 µm ± 0,5	1,2 µm ± 0,3
Drilling and Milling	HE B plus	AlTiSiN Multilayer	grey-schwarz	37	1000°C	3,5 µm ± 0,5	
Milling Hard Machining	HE S6 F	AlTiSiN + TiSiN	reddish gold	38	1100°C	2,5 µm ± 0,5	
Drilling and Milling	HE S6P	AlCrSiN + AlTiSiN	reddish gold	40	1100°C	3,5 µm ± 0,5	
General Drilling	HE S6 B	AlTiSiN + TiSiN	reddish gold	38	1100°C	4 µm ± 0,5	
Aluminum Machining	HE A Zr	CrTiAlN + ZrN	zirconium	28	800°C	1,5 µm ± 0,2	
Aluminum Machining	HE A	CrTiAlN	light silver	28	800°C	1,5 µm ± 0,2	
Titanium Machining	HE A plus	TiCCrN basiert	light silver	32	700°C	2,5 µm ± 0,5	1,2 µm ± 0,2
Steel / Stainless Steel Threading	HE Z	TiCN	pink	31	750°C	2,5 µm ± 0,5	
Milling General Machining	HE X	AlTiN	grey-schwarz	33	950°C	3,5 µm ± 0,5	1,2 µm ± 0,2
Hard Machining Thin Coating	HE P2	AlCrN + AlCrSiN	grey	38	1000°C		1,2 µm ± 0,2
Milling Steel Alloyed and Unalloyed	HE P3	AlCrN + AlCrSiN	grey	38	1000°C	2,5 µm ± 0,5	

1 Unalloyed Steels (C < 0,8%)

Strength: 200 HB | **Examples:** 1.0503 (C45), 1.0501 (C35), 1.0037 (St37), 1.0540 (C50)

Coating: The carbon content is low – risk of built-up edges (adhesive wear).

At high cutting rates, comparatively high temperatures occur. Tough, temperature-resistant coatings are necessary, e.g., columnar (pillar-like) structured TiAlN or AlTiN layers; for moderate cutting parameters, TiN or TiCN.

-> **Recommended Coatings:** HE B, TiN, HE Z, HE P3

2 Alloyed / Quenched and Tempered Steels (C < 1,7%, Alloying Elements < 5% (Ni, Cr, Mo, V, W))

Strength: 200 HB up to approx. 400 HB (1300 N/mm²) (34-40 HRC) generally good machinability,

but tempering and hardness must be considered. **Examples:** 1.7225 (42CrMo4), 1.7227 (42CrMoS4)

Coating: Coatings must be temperature-resistant and have high toughness. Particularly suitable are columnar-structured AlTiN coatings with high aluminum content, providing good oxidation resistance.

-> **Recommended Coatings:** HE B, AlTiN 4M, for high cutting parameters HE B plus, HE P3

3 High-Alloy Steels / Hot-Work Steels (Alloying Elements > 5%)

Strength: 40-50 HRC (1300 N/mm² - 1700 N/mm²) | **Examples:** 1.2343 (X37CrMoV5-1), 1.2344 (X40CrMoV5-1), 1.2365 (32CrMoV12-28)

Coating: With increasing hardness and alloy content, machinability decreases. For lower cutting parameters, the focus of the coating is on resisting abrasive wear. For finishing milling, AlTiSiN coatings with high silicon content are recommended.

For rough milling and drilling, AlTiN or AlTiSiN combinations are suitable. For AlTiN, the coating structure should change from columnar to fine nanocrystalline. For high operating temperatures, AlTiSiN coatings are recommended. For moderate operating temperatures, AlCrN-based coatings are suitable.

-> **Recommended Coatings:** HE X, HE S, HE S6, HE P3, HE S6P

4 Stainless Steels / Chromium-Nickel Steels

Examples: Ferritic Steels: 1.4003, 1.4005, 1.4057, 1.4021, 1.4108

Machining: Subject to adhesive wear, machinability depends on hardness, similar to quenched steels.

-> **Recommended Coatings:** HE X, HE B, HE Z for moderate cutting parameters, or HE P3

Examples: Austenitic Steels ca. 18% Cr / 8% Ni - 1.4301 (Typ 304), 1.4305, 1.4306, 1.4541 or 1.4307 (V2A without Mo)

Machining: At moderate cutting parameters, AlCrN or AlCrSiN-based coatings are recommended.

-> **Recommended Coating:** HE P3

Examples: Higher-Alloy Austenitic Steels: 1.4401, 1.4404, 1.4405, (V4A) | Machining: More difficult due to high Cr, Ni, Mo, and Ti content.

Preferably use AlTiSiN coatings; coatings should have increased thermal conductivity and temperature resistance.

-> **Recommended Coatings:** HE S6, HE S or HE P3

Examples: (Carbide-Containing Steels): 1.4436, 1.4435, 1.4539, 1.3952, 1.3964, 1.4571, 1.4362, 1.4501, 1.4507, Duplex Steels Cr 23- 26%; high Ni content. Machining: Increasingly difficult; high Cr content leads to carbides, resulting in high cutting forces and abrasive wear.

Combination coatings of AlTiN and AlCrSiN are recommended.

-> **Recommended Coatings:** HE F4, HE S, HE S6, HE P3, HE S6P

5 Hardened Steels / Cold-Work Steels

Strengths: > 2000 N/mm² (600 HV; 55 HRC) up to (840 HV, 65 HRC) | **Examples:** 1.0401, 1.2162, 1.2379 martensitic stainless steels or steels with C content > 0,3%

Tooling: High cutting edge angles on tools. | **Beschichtung:** Nanocrystalline coatings based on AlTiSiN.

-> **Recommended Coatings:** HE S or HE S6F

6 Cast Iron

Cast iron is a short-chipping material but may contain silicon carbides; therefore, coatings should be abrasion-resistant.

-> **Recommended Coatings:** HE B plus or HE S

7 Non-Ferrous Soft Metals

Aluminum, Bronze, Brass, Magnesium Alloys

Coatings: Generally, smooth, thin coatings based on Ti or Cr are used.

-> **Recommended Coatings:** HE A, HE A Zr

8 Titanium Alloys

Examples: 3.7164 TiAl6V45b, annealed titanium alloys < 900 N/mm²

-> **Recommended Coatings:** HE Z or HE A plus

3.7164 TiAl6V45c, hardened titanium alloys 900-1250 N/mm²

-> **Recommended Coatings:** HE S or HE S6 preferably with ZrN sliding layer

9 Nickel-Based Alloys

Examples: 2.4668 (Inconel or Alloy718)

Machining: Work hardening occurs during cutting. The tool should remain engaged, with low cutting speeds (Vc) and relatively high feed (fz).

Coatings: Due to high cutting forces, the cutting edge can overheat and experience local overload.

Therefore, the coating should have good thermal conductivity and excellent abrasion resistance.

-> **Recommended Coatings:** HE P3, HE S6, HE S6P